

PROCESS FOR PATTERNING TEXTILE MATERIALS AND FABRICS MADE THEREFROM

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FIELD OF THE INVENTION

10 The invention generally relates to a process for patterning textile materials. More specifically, the invention relates to a process for producing patterned textile materials using a dye process conventionally used for dyeing solid fabrics, and fabrics made using the process.

BACKGROUND

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Textile manufacturers are continually striving to achieve products having unique and different appearances. While designers can create seemingly infinite quantities of looks for fabrics, the fabric manufacturers must take into account such things as machinery capabilities, costs of raw materials, labor input and processing expenses, performance characteristics required of the fabric, and the like. Thus, the creativity of the designers is often limited by the ability of the manufacturers to efficiently produce the fabrics according to their designs.

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One traditional way of achieving patterned fabrics is by forming the fabric from alternating regions of differently colored, previously dyed yarns. The fabrics made in this manner are called yarn-dyed fabrics, and are used in the manufacture of such fabrics as woven striped broadcloth (e.g., of the variety commonly used in men's dress shirts). While providing a desirable appearance in many respects, there are some disadvantages to yarn-dyed fabrics, the main being that the yarns must be dyed in advance to the colors desired for use in the product. As will be readily apparent to those of ordinary skill in the art, this adds significantly to the lead time required to produce the fabric (since colors must be determined and the yarns dyed to achieve those

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colors prior to the fabric formation process) and it can be expensive to produce small lots of particular color combinations.

In addition, the fabric formation equipment (e.g. the loom or knitting machine) must be specifically set up to achieve the particular pattern desired. This can result in significant machine downtime between color and pattern changes. Furthermore, yarn-dyed fabrics have a tendency to shrink differentially due to component yarns having been exposed to different temperatures and conditions during their respective dyeing and processing conditions. As a result, yarn-dyed fabrics often pucker along the regions of transition between one yarn color and another following laundering. In summary, the yarn-dyed products require undesirably long lead times and manufacturing complexity, while achieving products that may have undesirable side-to-side variation.

Attempts have been made to achieve patterned fabrics by means other than the use of differently colored yarns in the fabric formation process. For example, fabrics are often directly printed with variously colored patterns. In this method, the colors for the desired designs are applied directly to the undyed or previously dyed fabric. The disadvantages of this type of patterning are twofold. First, where colors are being printed over a previously dyed fabric, the color palette is limited based upon the base shade. This is because some colors used in patterning will not be visible or will be changed because of the base shade showing through. An example would be a blue pattern printed on a yellow base shade. After printing, the pattern would likely appear to be green. Furthermore, a yellow pattern printed on the yellow base may not be visible at all. Therefore, with very dark base shades, very few printed dyes would be visible. This limits the designer to using only certain colors with particular base shades or dictates the use of an undyed base fabric in order to use the full color palette.

The second disadvantage of this type of patterning is encountered when using pigments to print over a base shade. It is generally known that the above-described problem of color limitations can be overcome by printing

pigments onto the surface of a dyed fabric as is commonly done in plastisol printing. In this way, even white and light colors can be patterned onto very dark backgrounds and the color selection is not limited. However, the resulting pattern has a somewhat stiff and/or rubbery feel and may have a raised appearance as compared to the feel and appearance of the unpatterned area. In many apparel applications, this is not desirable. Furthermore, with repeated launderings and/or abrasion, the printed pattern may eventually become brittle, crack and peel off.

Another method commonly used is called discharge printing. In discharge printing, the fabric is dyed (typically piece dyed), then printed in a pattern with a paste containing a chemical that reduces the dye, to thereby form white patterns within the dyed background. A colorant may also be added to the discharge paste so that the discharged color is replaced with another color. The discharge chemistry can tend to be harsh and often weakens the portions of the fabric to which it is applied, thereby reducing the overall strength of the fabric. Another disadvantage of this type processing is that only dyes that readily discharge to white when subjected to chemical reducing agents can be selected or there will be residual color left in the patterned area. This type of chemistry adds to the cost and reduces the flexibility of the process.

Another method used to produce patterned fabrics is called resist printing. In resist printing, a substance designed to resist dyeing of the fabric is applied to the fabric in a pattern. The fabric is then dyed using a discontinuous dye process. In prior resist printing processes, the resist agent was typically a water insoluble medium. Examples of patterning processes which use water insoluble media are batik, which uses wax, and tie dyeing, which uses elastic bands or the like to inhibit the dyeing of the fabric in particular regions. As will be readily appreciated by those of ordinary skill in the art, the use of these media requires an additional processing operation to remove the dye-inhibiting medium. Where the dye-inhibiting medium is wax, the removal process can be difficult and can result in damage to the underlying fabric regions. In tie-dye processes, removal of the bands is

likewise labor intensive. Furthermore, processes such as tie-dyeing are limited in the types of design configurations they can be used to produce, and the wax used in batik does not enable the portions of the fabric where it is applied to be simultaneously dyed a different color from the rest of the fabric.

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Another type of resist printing involves the chemical binding of the dye sites of the fibers in particular regions of the fabric. Typically, the resist chemistry will be printed on the fabric in a particular pattern prior to dyeing of the fabric. One example of this method is described in U. S. Patent No.

10 5,984,977 to Moore et al. which describes the use of a substance designed to chemically block the dye sites of a cellulosic material during a discontinuous dye process. Because the dye sites are bound by the resist chemistry, the fabric will not dye in the regions where the chemistry has been applied. While performing well in many applications, this process is somewhat limited in that
15 the resist chemistry must be selected to chemically block the dye sites of the particular fibers in the fabric, which may present a problem when the fabric to be patterned is made from a blend of fibers. For one, if one fiber in the blend is blocked and the other fiber is not prevented from dyeing, then a total resist of the patterned area cannot be achieved unless the unblocked fiber is left
20 undyed. This results in a heather effect on the base shade of the fabric, thereby limiting design flexibility. In addition, commercially available chemical resist processes are marketed for use in discontinuous dye processes, which have lower production speeds as compared with continuous and semi-continuous processes. Also, such resist chemistries are generally deleterious
25 to fabric strength.

Finally, heat transfer printing is also used to pattern fabrics. This method uses a paper printed with dyes that are subject to sublimation upon heating. The paper is placed in direct contact with the fabric and heat is
30 applied to transfer the dyes from the paper to the fabric by sublimation. Largely used with disperse dyes on polyester, heat transfer printing is normally performed in a dry state, with the heat applied also serving to diffuse the dye into the fiber. This method is primarily limited to disperse dyes that readily sublime. A variation of this method where the heat transfer is done in

a wet state allows other dye classes to be used that will readily transfer from the paper to the fabric in the vapor phase. Still, the dye selection is limited and a two-step process of printing the paper and then transferring the dye to the fabric is necessary. Furthermore, resist effects are not made by this process and designs are therefore limited by the base shade of the fabric prior to printing.

SUMMARY

The process of the instant invention enables the production of patterned fabrics in an efficient manner, while avoiding extra processing operations required by prior art methods. In addition, the process enables the production of fabrics having the surface appearance of yarn-dyed goods, while avoiding the complexity inherent in yarn-dye manufacturing methods and the fabric strength degradation provided by other dye methods. Furthermore, the process enables the manufacture of patterned fabrics using a continuous or semi-continuous dyeing operation, which achieve greater manufacturing efficiencies than typical discontinuous processes. For purposes of this application, the term "continuous or semi-continuous dye operation" is intended to mean those dye operations where the fabric generally lingers within the dye bath for a relatively short period of time, generally as a result of the continuous motion of the fabric through the process. For example, continuous and semi-continuous dye operations of the variety contemplated by the invention include thermosol dye processes, pad/steam processes, thermosol/pad/steam processes, pad/high temperature steam operations, jig dye processes, pad batch, and the like. Such processes are typically non-exhaust type processes. In contrast, discontinuous dye processes involve the dyeing of a "batch" of fabric, where the fabric spends an extended uninterrupted period of time in the dye liquor to achieve even dyeing through exhaustion and equilibrium.

The process involves applying to the fabric a chemical substance capable of temporarily mechanically inhibiting the wetting of underlying

regions of the fabric, and then continuously or semi-continuously dyeing the fabric. The chemical substance desirably comprises a print paste. In some embodiments of the invention, the chemical substance may comprise a fluorochemical. In some cases, the chemical substance may comprise both
5 fluorochemical and a print paste. In any event, the chemical substance is selected so that it mechanically inhibits the wetting of underlying regions of the fabric to which it is applied, while not requiring removal from the fabric by way of a separate removal operation. To this end, the chemical substance is desirably water soluble so that it is removed, if desired, by the subsequent
10 chemical and/or mechanical action of the normal dyeing and finishing processes.

The chemical substance can be selected to either totally inhibit wetting of the underlying fabric regions or only partially inhibit the dye uptake such
15 that the underlying fabric regions dye to a lesser extent than other areas of the fabric where the chemical substance was not provided. In a similar manner, the chemical substance can be selected to correspond with the particular dye process to be utilized so that the chemical substance is removed shortly before the end of the dye process and portions of the fabric
20 underlying the chemical substance are wet to a lesser extent than the base portions of the fabric, thereby having less of an opportunity to bond with the dye molecules in those regions. In this way, the portions of the fabric where the chemical substance was applied are dyed the same color as the uncovered fabric portions but at a lighter shade level. Therefore, a fabric
25 having a pattern formed from varied dye uptake amounts in predetermined regions can be efficiently manufactured.

The chemical substance may also include a dye such that the portions of the fabric on which the chemical substance is printed are dyed a different
30 color than those portions of the fabric dyed by the subsequent continuous dye process. The invention is not limited to the application of a single chemical substance, rather plural different chemical substances could be printed in different patterns within the scope of the invention. For example, a first pattern of a chemical substance which does not include dye could be applied

in a first pattern, while a second chemical substance which does include dye could be applied in a second pattern, to thereby produce a three-color patterned fabric. Additionally, a three or more color effect could be achieved using two different chemical substances having different resist characteristics printed in two or more different patterns.

The process of the invention enables the production of fabrics having a unique yarn-dyed appearance without the disadvantages associated with yarn-dyed products. For example, in one aspect of the invention, the pattern printed on the fabric is selected to correspond to the yarns in the fabric construction, to thereby give the appearance of a yarn-dyed fabric. In addition, the patterning capability and pattern clarity of fabrics printed in this manner far exceeds that of yarn-dyed goods, especially where intricate designs are desired. Furthermore, the fabrics retain substantially all of their initial strength, have good colorfastness, and have superior aesthetic and functional characteristics.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a flow diagram of one embodiment of the process of the instant invention;

Fig. 2 is a photograph (40X magnification) of a conventional yarn-dyed product; and

Fig. 3 is a photograph (40X magnification) of a fabric made according to the invention.

DETAILED DESCRIPTION

In the following detailed description of the invention, specific preferred embodiments of the invention are described to enable a full and complete understanding of the invention. It will be recognized that it is not intended to limit the invention to the particular preferred embodiment described, and

although specific terms are employed in describing the invention, such terms are used in a descriptive sense for the purpose of illustration and not for the purpose of limitation.

5 With reference to the drawings, Fig. 1 illustrates a process for manufacturing patterned fabrics according to the instant invention. As noted, the steps performed in this aspect are printing resist chemistry on the fabric, drying the chemistry (optional), applying the dye, pre-drying the dye (if desired), setting the dye, cooling the fabric (if previously heated), applying
10 chemistry as desired, reacting the chemistry if necessary, washing the fabric to remove excess chemistry, and drying and taking up the fabric. As will be appreciated by those of ordinary skill in the art, the specific steps used will vary according to the dye process used, type of fabric being patterned, chemistry used, pattern sought, etc. The steps will be discussed more
15 specifically below.

 The fabric to be patterned is obtained. The fabric can be of any variety, including a woven fabric, a knit fabric, nonwoven fabric, or the like. The fabric can be formed of any conventional type of fibers that are capable of
20 being continuously or semi-continuously dyed, including but not limited to synthetic fibers such as polyesters (including, but not limited to polyethylene terephthalate, polytrimethylene terephthalate (PTT) and modified versions thereof), polyamides, polypropylene, aramids, polyolefins, regenerated fibers such as polylactide based fibers (PLA) and rayon (e.g. viscose,
25 cuprammonium), natural fibers such as cotton, linen, ramie, hemp, jute, or the like, or combinations thereof. The process of the invention has been found to perform particularly well in the production of 100% polyester, 100% cotton, and polyester/cotton blended fabrics. The fabric will be selected to provide the weight and performance characteristics desired for the end use product.

30 The fabric is desirably in prepared form, meaning that it has been washed to remove oils, impurities and the like which it has picked up during the manufacturing and/or transport processes. Preferably, the fabric is dried

as part of the preparation process so that a consistent product is presented for chemical substance application and dyeing.

A chemical substance designed to temporarily inhibit the wetting of the underlying fabric areas is then applied to the fabric in a desired pattern. The chemical substance is desirably applied to the fabric by a printing process. For example, the printing process can be roller bed printing, rotary screen printing, flexographic printing, gravure roll application, multiple nozzle injection patterning (such as that described in commonly-assigned U.S. Patent No. 4,923,743), or the like. However, other application methods are contemplated within the scope of the invention including, but not limited to flick brush, ultrasonic spray, foam application, print head pattern methods, and the like. The chemical substance can be applied in any desired pattern. Alternatively, the application "pattern" can be that of randomized spots or the like (e.g. such as those achieved with a flick brush.) As will be readily appreciated, the regions where the chemistry is applied will determine the pattern of undyed or differentially dyed areas on the finished fabric, and the variety of application patterns is essentially limitless. As a result, the process can be used to achieve a limitless variety of fabric appearances.

The chemical substance is designed to physically inhibit the wetting of underlying regions of the fabric for a period of time. In one aspect of the invention, the chemical substance is designed to prevent wetting of the underlying regions of the fabric for a period of time greater than the fabric is in contact with the aqueous dye liquor. In another aspect of the invention, the chemical substance can be selected to prevent saturation of the underlying regions while allowing some wetting, either by virtue of the length of time it inhibits wetting or the degree it inhibits wetting. The fabric may retain the property of being inhibited from wetting after processing since the downstream processing does not require the removal of the chemistry. (In contrast, prior means of mechanically inhibiting the wetting of fabric areas such as wax require a separate processing step to remove the substance, since the fabric would not have the aesthetic and performance characteristics

sufficient to render it useful until such time as that substance was removed.)
To this end, the chemical substance is desirably water soluble.

Stated differently, the chemical substance is selected to inhibit wetting
5 of the underlying portions of the fabric, and preferably to totally inhibit wetting.
Where the chemical substance is designed to partially inhibit wetting of the
fabric, it can be selected to allow underlying portions of the fabric to wet at a
significantly slower rate than the untreated regions, or it can be selected to
inhibit wetting for a period of time somewhat shorter than the length of the dye
10 process. In this way, portions of the fabric on which the chemical substance
has been printed will be exposed to a lesser amount of the dye and/or
exposed for a lesser length of time than the untreated fabric regions. As a
result, the portions of the fabric that were treated with the chemical substance
will be dyed the same basic color (hue) as the surrounding fabric regions, but
15 with a depth of shade ranging from slightly lighter to much lighter than the
untreated regions.

The chemical substance preferably includes a print paste comprising a
thickening agent and water. In some forms of the invention, the chemical
20 substance includes a fluorochemical. In some forms of the invention, the
chemical substance includes both a print paste and a fluorochemical. In any
event, the chemical substance is selected so that it inhibits the wetting of
underlying regions of the fabric to which it is applied, while not requiring
removal from the fabric by way of a separate removal operation, as will be
25 discussed further herein.

Examples of chemical substances that have been found to perform well
in the instant invention are alginate-based print pastes, xanthan-based print
pastes, synthetic-thickener-based print pastes, a wide variety of
30 fluorochemicals, and combinations thereof. The viscosity and rheology of the
chemical substance will be selected to optimize wetting inhibition and to
achieve the intended design appearance in the finished fabric. As will be
readily appreciated by those of ordinary skill in the art, the precise chemical
substance formulation used will be selected to accommodate the application

method used, screen or mesh size, add-on desired, etc. Such parameters are all contemplated within the scope of the invention, with the precise formulations used for each fabric being readily discernable without undue experimentation. It has been found that in a rotary screen print process (such as that used herein in the examples), a chemical substance viscosity of about 8 poise to about 70 poise, and preferably about 10 poise to about 40 poise (depending on the thickening agent used) performs well. The chemical substance will be applied at a pressure designed to achieve even printing with adequate penetration for the specific chemical substance and substrate used. For example, pressure ranges of about 3 psi to about 10 psi have been found to perform well for the chemical substances described above. In addition, the pressure at which the chemical substance is applied will be selected to optimize penetration of the substance into the particular fabric to the extent necessary to achieve the desired design and to achieve evenly printed goods. Likewise, the rheology of the chemical substance desirably provides good flow and quick stop characteristics.

In some forms of the invention, the chemical substance will also include a dye. In this way, the portions of the fabric on which the chemical substance is applied will be printed a first color, while surrounding regions of the base fabric not having the chemical substance thereon will be dyed a different color during the dye process. As will be readily appreciated by those of ordinary skill in the art, the chemical substances may be applied more than once using different patterns and different chemical substances. Therefore, the process can be used to form an essentially infinite number of fabric patterns and appearances. For example, the chemical substance can be applied to the fabric such that it mimics the pattern of yarns in a fabric construction, such as through a pattern of stripes printed in the direction of warp or filling yarns on a woven fabric to simulate a yarn-dyed striped fabric. Furthermore, the chemical substance may include other types of chemicals such as optical brighteners, different dye classes, copolymers, any type of chemistry that provides an additional benefit without interfering with the properties necessary for this invention to operate, and the like.

In most instances, it will be desirable to dry the chemistry prior to the subsequent dyeing step. This can be done by way of any method conventionally used to dry fabrics, such as by passing the fabric through an oven. This helps secure the chemical substance to the underlying fabric portions. The temperature and method used will be selected to optimize performance of the chemical substance and substrate used.

The fabric is then dyed in a conventional continuous or semi-continuous manner such as by a thermosol dye process. However, other types of dye operations such as pad/steam processes, thermosol/pad/steam processes, cold pad batch, jig dye processes, and the like can also be used within the scope of the instant invention with varying effects. As will be appreciated by those of ordinary skill in the art, the dyeing process used will be selected depending on the type of fabric being processed as well as the type of dye to be used. Similarly, the type and amount of chemical substance used will be selected to optimize the appearance of the dyed fabric. In other words, the type of dye process and chemical substance will be coordinated so that the mechanical inhibition of wetting provided by the chemical substance survives the specific dye process used to the extent necessary to achieve the desired patterned effect from dyeing. Similarly, the dye method utilized will be selected to achieve the desired results for the particular fabric being produced. For example, in many cases it will be desirable to utilize high efficiency continuous and semi-continuous dye processes; in such cases the yarns forming the fabric will often be ring dyed.

When a thermosol/pad-steam process is used, the process generally goes as follows: The fabric having the chemical substance applied to it is routed through the dye pad, where the fabric is saturated with dye, with the exception of those regions where the chemical substance prevents the fabric from fully wetting. The fabric is desirably pre-dried, and then heated to a temperature sufficient to sublime the dyestuff into the substrate such that the dyes sublime and penetrate into the fibers. The fabric is then desirably steamed, scoured and washed in a conventional manner to remove any excess chemistry and dye that may remain. The fabric is cooled, and any

finish chemistries that are desired can be applied. For example, chemistries designed to promote soil release and wicking, or reduce static and/or pilling, etc. can be provided according to the needs of the fabric. In addition, any desired face finishing operations can also be performed as needed. The fabric is then desirably dried and packaged for distribution.

The dye utilized can also be selected to achieve the type of appearance desired. For example, where the textile fabric is a polyester/cotton blended fabric and it is desired to have a solid-colored base fabric, a combination of disperse and vat dyes may be utilized to achieve dyeing of both the polyester and cotton constituents. In this instance, a thermosol/pad/steam process could be utilized with the additional steps of steaming, scouring and washing added to the process described above after the thermosol oven. Alternatively, the dye bath may include dyes that are designed to dye only one of the fiber constituents, so as to achieve a heather type appearance of the base fabric. For example, a polyester/cotton blended fabric could be exposed to disperse dyes only, which will dye the polyester component while leaving the cotton component substantially undyed, to thereby achieve a unique appearance of the base fabric.

As noted above, the chemical substance is selected to at least temporarily inhibit wetting of portions of the fabric, so that a pattern can be produced on the fabric during a continuous or semi-continuous dye process. The nature of the chemical substance results in it not requiring a subsequent removal process. In other words, the action of the dye process, drying, finishing and/or scouring operations serve to remove any of the chemistry that would interfere with the end performance of the fabric. For example, where the chemical substance includes or consists essentially of a print paste, the subsequent processing steps generally serve to remove the print paste from the fabric. By the same token, where the chemical substance comprises or consists essentially of a fluorocarbon, it may be desirable for some of the fluorocarbon chemistry to remain on the fabric in order that long term water repellency in the printed areas is achieved. In any event, the chemical substance and dye process used can be coordinated so that the amount of

the chemical substance that remains on the fabric following processing is controlled at desired levels.

As illustrated by a comparison of the yarn-dyed fabric in Fig. 2 and the fabric of the invention illustrated in Fig. 3, the fabrics produced according to the process of the invention have superior appearance, in many cases closely approximating the appearance of yarn-dyed fabrics, while avoiding the problems with that production process. For example, the differential shrinkage problems commonly associated with yarn-dyed fabrics can be avoided because the base fabric can be produced in a uniform construction if so desired. The fabrics of the invention also have good performance characteristics such as good uniform physical strength, appearance, colorfastness, washfastness, design durability, and a consistent feel or hand across patterned and unpatterned areas.

EXAMPLES

Three samples of commercially-available yarn-dyed shirting fabrics were obtained and are described below as Samples A, B and C.

Sample A was a bright blue and dark grey striped conventional poplin fabric having a weight of 4.3 oz/sq yd. The finished construction had 102 ends per inch and 57 picks per inch. Both warp and filling yarns consisted of a 65% polyester and 35% cotton blend. It is believed by the inventors that the fabric had been treated with conventional soil release and permanent press chemistries, and lightly sanded.

Sample B was a conventional poplin fabric having small blue stripes on a white background. The fabric had a weight of 4.3 oz/ sq yd and a finished construction having 77 ends per inch and 59 picks per inch. Both warp and filling yarns consisted of a 65% polyester and 35% cotton blend. It is believed by the inventors that the fabric had been treated with conventional soil release and permanent press chemistries, and lightly sanded.

Sample C was a conventional poplin fabric having multi-colored stripes. The fabric had a weight of 4.3 oz/ sq yd and a finished construction of 104 ends per inch and 60 picks per inch. Both warp and filling yarns consisted of a 65% polyester and 35% cotton blend. It is believed by the inventors that the fabric had been treated with conventional soil release and permanent press chemistries, and lightly sanded.

Sample D was a 4.3 oz 65/35 polyester/cotton poplin fabric. The fabric was dyed in a thermosol at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. (In other words, the fabric was dyed the same base shade as Sample E below.) The fabric was then finished in a conventional manner, by padding on conventional type finish chemistry to provide moisture transport, soil release and permanent press characteristics, running it through a tenter in a conventional manner to cross-link the resin and set the fabric width. The fabric was then mechanically abraded in the manner described in commonly-assigned U.S. Patent No. 5,752,300 to Dischler and treated with high pressure air (to form microfissures in the resin chemistry) in the manner described in commonly-assigned U.S. Patent No. 5,822,835 to Dischler. The fabric had a finished construction of 102 ends per inch and 47 picks per inch.

Sample E was woven in the same construction as Sample D, prepared, and then a twin stripe pattern from a 165 mesh screen of the following chemical substance was applied to the fabric: 60 g/kg fluorochemical (APG-85 from Advanced Polymer, Inc.), 11g/kg of a synthetic back thickener, 929 g/kg alginate stock print paste which included 32.5 g/kg of a low viscosity alginate thickener, a sequestering agent, a defoamer, an antimicrobial, and water. (As will be readily appreciated by those of ordinary skill in the art, the sequestering agent, defoamer and antimicrobial were provided in minor quantities to facilitate the performance of the printing equipment.) The chemical substance also included 1.35 g/kg disperse red mix, 0.41 g/kg

disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The mix had a viscosity of 38 poise, and was applied using a 40mm metal blade at a pressure of about 11 psi. The chemical substance was dried at 320°F. The fabric was then dyed in a thermosol at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then finished in the manner described with respect to Sample D. The finished fabric had a weight of 4.36 oz /sq yd, with 101 ends per inch and 48 picks per inch.

Sample F was woven in the same construction as Sample D, prepared, and then a wide stripe pattern of the following chemical substance was applied to the fabric: 60 g/kg fluorochemical (APG-85 from Advanced Polymer, Inc. of Carlstadt, New Jersey), 11g/kg of a synthetic back thickener, 929 g/kg alginate stock print paste (which included 32.5 g/kg of a low viscosity alginate thickener, a sequestering agent, a defoamer, an antimicrobial, and water). The chemical substance also included 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The mix had a viscosity of 38 poise, and was applied using a 40mm metal blade at a pressure of about 11 psi. The chemical substance was dried at 370°F. The fabric was then dyed in a thermosol at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then finished in the manner described above with respect to Sample D. The finished fabric had a weight of 4.41 oz/ sq yd and a construction of 101 ends and 48 picks per inch.

Sample G was woven in the same manner as Sample D, prepared, and then a wide stripe pattern of the following chemical substance was applied to the fabric: 60 g/kg fluorochemical (APG-85 from Advanced Polymer, Inc. of Carlstadt, New Jersey), 11g/kg synthetic back thickener, 929 g/kg alginate stock print paste (which included a 32.5 g/kg of a low viscosity alginate thickener, a sequestering agent, a defoamer, an antimicrobial, and water.) The chemical substance also included 1.35 g/kg disperse red mix, 0.41 g/kg

disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The mix had a viscosity of 38 poise, and was applied using a 40mm metal blade at a pressure of about 11 psi. The chemical substance was dried at 350°F. The fabric was then dyed in a thermosol at 425°F for 50 seconds with the following dye

5 mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then finished in the manner described above with respect to Sample D. The finished fabric had a weight of 4.36 oz/ sq yd, with 101 ends and 48 picks per inch.

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Sample H was woven in the same manner as Sample D, prepared, and then a twin stripe pattern of the following chemical substance was applied to the fabric: 60 g/kg fluorochemical (APG-85 from Advanced Polymer, Inc.), 11g/kg of a synthetic back thickener, 929 g/kg alginate stock print paste

15 (which included 32.5 g/kg of a low viscosity alginate thickener, a sequestering agent, a defoamer, an antimicrobial, and water). The chemical substance also included 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The mix had a viscosity of 38 poise, and was applied using a 40mm metal blade at a pressure of about 11 psi. The

20 chemical substance was dried at 350°F. The fabric was then dyed in a thermosol at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then finished in the manner described

25 above with respect to Sample D. The finished fabric had a weight of 4.31 oz/ sq yd and a construction of 101 ends and 48 picks per inch.

Sample I was woven in the manner of Sample D, prepared, and then a wide stripe pattern of the following chemical substance was applied to the

30 fabric: 60 g/kg fluorochemical (APG-85 from Advanced Polymer, Inc.), 11g/kg of a synthetic back thickener, 929 g/kg alginate stock print paste (which included 32.5 g/kg of a low viscosity alginate thickener, a sequestering agent, a defoamer, an antimicrobial, and water). The chemical substance also included 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg

disperse violet 57 dye. The mix had a viscosity of 38 poise, and was applied using a 40mm metal blade at a pressure of about 11 psi. The chemical substance was dried at 320°F. The fabric was dyed in a thermosol at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then finished in the manner described above with respect to Sample D. The finished fabric had a weight of 4.35 oz/ sq yd and a construction of 102 ends and 48 picks per inch.

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Sample J was woven in the manner of Sample D, prepared, and then a twin stripe pattern of the following chemical substance was applied to the fabric: 60 g/kg fluorochemical (APG-85 from Advanced Polymer, Inc.), 11g/kg synthetic back thickener, 929 g/kg alginate stock print paste (which included 32.5 g/kg of a low viscosity alginate thickener, a sequestering agent, a defoamer, an antimicrobial, and water). The chemical substance also included 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The mix had a viscosity of 38 poise, and was applied using a 40mm metal blade at a pressure of about 11 psi. The chemical substance was dried at 370°F. The fabric was then dyed in a thermosol at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then finished in the manner described above in Sample D. The finished fabric had a weight of 4.34 oz/sq yd and a construction of 102 ends by 48 picks per inch.

Sample K was woven in the manner of Sample D, then a twin stripe pattern of the following chemical substance was applied to the fabric: 60 g/kg fluorochemical (APG-85 from Advanced Polymer, Inc), 11g/kg synthetic back thickener, 929 g/kg alginate stock print paste (which included 32.5 g/kg of a low viscosity alginate thickener, a sequestering agent, a defoamer, an antimicrobial, and water). The chemical substance also included 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57

dye. The mix had a viscosity of 38 poise, and was applied using a 40mm metal blade at a pressure of about 11 psi. The chemical substance was dried at 385°F. The fabric was then dyed in a thermosol at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then finished in the manner described above in Sample D. The fabric had a finished weight of 4.4 oz/sq yd and a construction of 102 ends by 48 picks per inch.

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Sample L was woven in the manner of Sample D, then a wide stripe pattern of the following chemical substance was applied to the fabric: 60 g/kg fluorochemical (APG-85 from Advanced Polymer, Inc.), 11 g/kg synthetic back thickener, 929 g/kg alginate stock print paste (which included 32.5 g/kg of a low viscosity alginate thickener, a sequestering agent, a defoamer, an antimicrobial, and water). The chemical substance also included 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The mix had a viscosity of 38 poise, and was applied using a 40mm metal blade at a pressure of about 11 psi. The chemical substance was dried at 385°F. The fabric was then dyed in a thermosol at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then finished in the manner described above in Sample D. The finished fabric had a weight of 4.42 oz/sq yd and a construction of 101 ends by 48 picks per inch.

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Sample M was woven in the manner of Sample D, then a mesh pattern of the following chemical substance was applied to the fabric: 60 g/kg fluorochemical (APG-85 from Advanced Polymer, Inc.), 11 g/kg of a synthetic back thickener, 929 g/kg alginate stock print paste (which included 32.5 g/kg of a low viscosity alginate thickener, a sequestering agent, a defoamer, an antimicrobial, and water). The chemical substance also included 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57

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dye. The mix had a viscosity of 38 poise, and was applied using a 40mm metal blade at a pressure of about 11 psi. The chemical substance was dried at 385°F. The fabric was then dyed in a thermosol at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then finished in the manner described above in Sample D. The finished fabric had a weight of 4.42 oz/sq yd and a construction of 101 ends by 48 picks per inch.

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Sample N was woven in the manner of Sample D, then a mesh pattern of the following chemical substance was applied to the fabric: 60 g/kg fluorochemical (APG-85 from Advanced Polymer, Inc.), 11g/kg of a synthetic back thickener, 929 g/kg alginate stock print paste (which included 32.5 g/kg of a low viscosity alginate thickener, a sequestering agent, a defoamer, an antimicrobial, and water). The chemical substance also included 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The mix had a viscosity of 38 poise, and was applied using a 40mm metal blade at a pressure of about 11 psi. The chemical substance was dried at 385°F. The fabric was then dyed in a thermosol at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then finished in the manner described above in Sample D. The finished fabric had a weight of 4.33 oz/sq yd and a construction of 102 ends by 48 picks per inch.

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TEST METHODS:

For purposes of these tests, the term “industrial washes” is intended to describe the wash process described below.

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Industrial Wash Test:

PROCEDURE:

1. Weigh samples to make a 15 \pm 1) pound load.
Note: Use 100% cotton white dummies if necessary to achieve the proper load weight.

5 2. Industrial Laundry Process Specifications (Milnor Washer):

	<u>Process</u>	<u>W/L</u>	<u>Temp.</u>	<u>Time</u>	<u>Supplies</u>	<u>PH</u>	<u>Alkalinity Available</u> (ppm)	<u>Total</u>
10	BREAK	LOW	Add Steam to 165	15 min	16.5(\pm 1) oz Orthosil or 300(\pm 10)ml 2.8(\pm 0.2) oz IFL # 15 or 50(\pm 2) ml	11.5-12.5	2826	3964
15	CARRYOVER	LOW	140-155	5 min.	None	11.0-12.0	1880	2459
20	RINSE	HIGH	120-130	2 min.	None	10.2-10.8	148	299
	RINSE	HIGH	110-120	2 min.	None	10.2-10.8	99	205
	RINSE	HIGH	100-110	2 min.	None	9.0-10.0	50	173
25	RINSE	HIGH	90-100	2 min.	None	9.0-10.0	12	46
30	SOUR	LOW	90-100	5 min.	.25(\pm 0.05) oz. Sour or 7(\pm 0.5) milliliters	6.5-7.0	---	---

3. Start the cycle with the signal switch in the down position.
4. W/L refers to water level. LOW = 12 gallons and HIGH = 24 gallons.
5. Take 4 (\pm .25) pounds out of the 15 (\pm 1) pound load and place in the Sears Kenmore Home Dryer. (Insure all of the samples are placed in the dryer, if you have more than 4.25 pounds of samples, split them into two loads with an even number of samples in each. The balance of each load should be made up of dummy fabric.)
6. Set the dryer on the Cotton Sturdy setting for 30 minutes. Insure the samples are completely dry prior to removing them from the dryer.
7. Repeat the above wash and dry steps for the specified number of cycles.

Note: Orthosil = Orthobrite

- 50 Tensile Strength: The tensile strength of each of the fabric samples was tested in each of the warp and fill directions according to ASTM D-5034-95. A number of the samples were also tested after 10, 25, 50 and 100 Industrial Washes.

Tear Strength: The tear strength of each of the fabric samples was tested in each of the warp and fill directions using an Elmendorf Tear Test according to ASTM D1424-96. A number of the samples were also tested after 10, 25, 50 and 100 industrial washes.

Seam Slippage: Seam slippage was tested in both the warp and fill directions according to the ASTM D-434-42 Test Method.

Flex: Fabric flexion was tested in both the warp and fill directions according to ASTM D3885-99.

Appearance: Fabrics were washed according to the above-described wash methods, and rated according to AATCC Test Method 124-1992.

Pilling: Fabric pilling was tested according to ASTM D-3512-99A. For the yarn dyed products, it was tested as received and after 10, 25 and 50 industrial washes. For the fabrics of the invention, pilling was tested as received.

Color Data: Raw color data was measured using a 10 degree spherical spectrophotometer, with a D65, specular excluded light source with a UV filter set at 0%. The untreated regions were as the standard and the treated regions were read as the sample. The DE, DL, Da and Db were calculated using the following formulae:

$$DL = L_1 - L_2, \text{ with } L_1 \text{ being the untreated and } L_2 \text{ being the treated.}$$

$$Da = A_1 - A_2, \text{ with } A_1 \text{ being the untreated and } A_2 \text{ being the treated.}$$

$$Db = B_1 - B_2, \text{ with } B_1 \text{ being the untreated and } B_2 \text{ being the treated.}$$

$$DE = \sqrt{DL^2 + Db^2 + Da^2}$$

$$\% \text{ Strength} = \frac{\text{area under reflectance curve of treated area}}{\text{area under reflectance curve of untreated area}}$$

- 5 DE is indicative of the overall color difference between the two areas, while DL is indicative of the difference in depth of shade. For example, a DL of zero would indicate there was no difference in the depth of shade between the two areas. Da is indicative of the difference in red/green hues, while Db is indicative of differences in yellow/blue hues. The Strength rating illustrates
- 10 the % difference in the color for the two regions. For those samples where the resist chemistry did not include a dye, a low strength number would illustrate a high amount of resist.

The results of each of the tests are recorded below in Tables A and B.

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TABLE A

	A	B	C	D	E	F	G
WIDTH	N/A	N/A	N/A	---	64.63	64.63	64.75
WEIGHT oz/sq yd	4.3	4.3	4.3	4.3	4.36	4.41	4.36
ENDS	102	77	104	102	101	101	101
PICKS	57	59	60	47	48	48	48
TENSILE WASH	119	101	117	112	113	111	112
Tensile W 10W	115	110	96	---	129	121	130
Tensile W 25 W	110	103	97	---	116	115	109
Tensile W 50W	102	98	71	---	98	110	101
Tensile W 100W	---	---	---	---	99	90	94
TENSILE F As Rec'd	59	78	64	77	80	74	71
Tensile F 10W	60	78	66	---	82	79	84
Tensile F 25W	51	73	56	---	82	77	79
Tensile F 50W	36	64	51	---	74	75	74
Tensile F 100W	---	---	---	---	77	76	77
TEAR W AR	2246	2588	2096	2035	2300	2200	1900
Tear W 10W	1958	2166	1833	---	2000	1700	1725
Tear W 25W	1635	1801	1440	---	1750	1650	1575
Tear W 50W	1267	1478	1136	---	1750	1800	1700
Tear W 100W	---	---	---	---	1650	1475	1400
TEAR F AR	1401	1715	1264	2100	1950	2100	2250
Tear F 10W	1305	1446	1126	---	1650	1700	1725
Tear F 25W	931	1267	838	---	1600	1650	1650

Tear F 50W	688	976	627	---	1850	2100	1900
Tear F 100W	---	---	---	---	1500	1650	1550
SS WARP	40	40	40	37	33	34	35
SS FILL	40	40	40	40	40	40	40
FLEX WARP	2000	2000	2000	2000	2000	2000	2000
FLEX FILL	2000	2000	2000	2000	2000	2000	2000
APPEARANCE	3	3	3	3.6	3.5	3.5	3.5
PILL AR	4	4.5	4	---	4	4	4
PILL 10w	4	4.5	4	3.5	---	---	---
PILL 25w	4.5	4.5	4.5	---	---	---	---
PILL 50w	4.5	4.5	4.5	---	---	---	---

TABLE B

	H	I	J	K	L	M	N
WIDTH	64.63	64.75	64.88	64.63	64.75	64.63	64.5
WEIGHT	4.31	4.35	4.34	4.4	4.42	4.42	4.33
ENDS	101	102	102	102	101	101	102
PICKS	48	48	48	48	48	48	48
TENSILE W	109	114	119	108	104	112	101
Tensile W 10W	124	119	115	110	109	123	105
Tensile W 25 W	113	108	114	113	118	107	105
Tensile W 50W	107	105	97	95	109	105	107
Tensile W 100W	99	84	91	73	95	94	95
TENSILE F AR	77	74	74	69	76	73	70
Tensile F 10W	82	82	82	76	80	82	77
Tensile F 25W	85	78	80	74	84	82	76
Tensile F 50W	80	73	72	60	65	82	77
Tensile F 100W	78	77	77	68	70	74	74
TEAR W AR	1975	1975	2000	1850	2100	1900	2050
Tear W 10W	1700	1750	1500	1550	1700	1750	1750
Tear W 25W	1600	1750	1750	1600	1675	1650	1700
Tear W 50W	1800	1800	1900	1000	1750	1750	1800
Tear W 100W	1400	1450	1500	1250	1400	1500	1450
TEAR F AR	2100	2200	2150	1925	2200	2100	2300
Tear F 10W	1700	1575	1450	1750	1600	1675	1750
Tear F 25W	1800	1800	1850	1625	1750	1750	1600
Tear F 50W	2000	2025	1975	1500	1950	1400	1950
Tear F 100W	1750	1550	1600	1500	1550	1650	1575
SS WARP	31	33	30	36	36	34	34
SS FILL	40	40	40	40	40	40	40
FLEX WARP	2000	2000	2000	2000	2000	2000	2000
FLEX FILL	2000	2000	2000	2000	2000	2000	2000

APPEARANCE	3.5	3.5	3.5	3.5	3.5	3.5	3.5
PILL AR	4	4	4	4	4	4	4
PILL 10w	---	---	---	---	---	---	---
PILL 25w	---	---	---	---	---	---	---
PILL 50w	---	---	---	---	---	---	---

Samples AA through AP were all done in the lab. A lab thermosol pad steam was used. None of the fabrics were finished.

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Sample AA was a 4.3 oz 65/35 polyester/cotton poplin fabric. The fabric was printed on a lab scale strike table in a wide bar pattern with an alginate based print paste containing 11.5g/kg of a synthetic back thickener, and a 988.5g/kg of a stock print paste containing an anginate thickener, a sequestering agent, a defoamer, an anti-microbial agent, and water. (As in the above samples, the sequestering agent, defoamer and anti-microbial agent were included in minor quantities to facilitate the performance of the printing.) The paste had a viscosity of 25 poise. The chemical substance was dried on a laboratory infrared conveyor dryer of the variety marketed by Glenro Inc. of Paterson, New Jersey, set at 65% output with a conveyor speed of 1.96 m/min. and a temperature between 220 and 330°. The fabric was then dyed in a lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 5.10 g/l CI Disperse Orange 30, 11.97 g/l CI Disperse Blue 165, and 5.65 g/l CI Disperse Rubine Mix. The fabric was then dried in the infrared drying unit at a temperature not exceeding 300°F.

Sample AB was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with an alginate based print paste as described above in Sample AA and which also included 6% of the fluorochemical APG 5264 from Advanced Polymer, Inc. Carlstadt, New Jersey. The chemical substance was dried on a laboratory infrared conveyor dryer as described in Sample AA. The fabric was then dyed in lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 5.10 g/l CI Disperse Orange 30, 11.97 g/l CI Disperse Blue 165, and 5.65 g/l CI Disperse Rubine

Mix. The fabric was then dried in the infrared drying unit at a temperature not exceeding 300°F.

Sample AC was the same base fabric as Sample AA. The fabric was
5 printed in a wide bar pattern with an alginate based print paste as described
above in Sample AA and which also included 6% of the fluorochemical APG
85 from Advanced Polymer, Inc. The chemical substance was dried in the
manner described in Sample AA. The fabric was then dyed in a lab
thermosol/pad/steam unit at 425°F for 50 seconds with the following dye
10 mixture: 5.10 g/l CI Disperse Orange 30, 11.97 g/l CI Disperse Blue 165, and
5.65 g/l CI Disperse Rubine Mix. The fabric was then dried in the infrared
drying unit at a temperature not exceeding 300°F.

Sample AD was the same base fabric as Sample AA. The fabric was
15 printed in a wide bar pattern with an alginate based print paste as described
above in Sample AA and which also included 10% of Solopol ZB30, a sugar
co-polymer supplied by Stockhausen, Inc. of Greensboro, North Carolina.
The chemical substance was dried in the manner described above in Sample
AA. The fabric was then dyed in a lab thermosol/pad/steam unit at 425°F for
20 50 seconds with the following dye mixture: 5.10 g/l CI Disperse Orange 30,
11.97 g/l CI Disperse Blue 165, and 5.65 g/l CI Disperse Rubine Mix. The
fabric was then dried in the infrared drying unit at a temperature not
exceeding 300°F.

Sample AE was the same base fabric as Sample AA. The fabric was
25 printed in a wide bar pattern with an alginate based print paste as described
above in Sample AA. The chemical substance was dried in the manner
described above in Sample AA. The fabric was then dyed in a lab
thermosol/pad/steam unit at 425°F for 50 seconds with the following dye
30 mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165,
0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat
Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then dried in the
infrared drying unit at a temperature not exceeding 300°F.

Sample AF was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with an alginate based print paste as described above in Sample AA. The paste also included 6% of the fluorochemical APG 5264 from Advanced Polymer, Inc. The chemical substance was dried in the manner described above in Sample AA. The fabric was then dyed in lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then dried in the infrared drying unit at a temperature not exceeding 300°F.

Sample AG was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with an alginate based print paste as described above in Sample AA. The paste also included 6% of the fluorochemical APG 85 from Advanced Polymer, Inc. The chemical substance was dried in the manner described above in Sample AA. The fabric was then dyed in a lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then dried in the infrared drying unit at a temperature not exceeding 300°F.

Sample AH was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with an alginate based print paste as described above in Sample AA. The paste also included 10% of Solopol ZB30, a sugar co-polymer supplied by Stockhausen, Inc. of Greensboro, North Carolina. The chemical substance was dried in the manner described in Sample AA. The fabric was then dyed in a lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then dried in the infrared drying unit at a temperature not exceeding 300°F.

Sample AI was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with an alginate based print paste as described above in Sample AA. The paste also included 10% of Solopol ZB30, a sugar co-polymer supplied by Stockhausen, Inc. of Greensboro, North Carolina and 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The chemical substance was dried in the manner described in Sample AA. The fabric was then dyed in a lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, and 0.700 g/l CI Disperse Rubine Mix. The fabric was then dried in the infrared drying unit at a temperature not exceeding 300°F.

Sample AJ was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with an alginate based print paste as described above in Sample AA. The print paste also included 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The chemical substance was dried in the manner described in Sample AA. The fabric was then dyed in a lab thermosol/pad/steam unit I at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, and 0.700 g/l CI Disperse Rubine Mix. The fabric was then dried in the infrared drying unit at a temperature not exceeding 300°F.

Sample AK was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with an alginate based print paste as described above in Sample AA. The print paste included 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The paste also included 6% of the fluorochemical APG 5264 from Advanced Polymer Inc. The chemical substance was dried on a laboratory infrared conveyor dryer set at 65% output with a conveyor speed of 1.96 m/min. The fabric was then dyed in a lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, and 0.700 g/l CI Disperse Rubine Mix. The fabric was then dried in an infrared drying unit at a temperature not exceeding 300°F.

Sample AL was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with an alginate based print paste as described above in Sample AA and also included 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The paste also included 6% of the fluorochemical APG 85. The chemical substance was dried in the manner described in Sample AA. The fabric was then dyed in a lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, and 0.700 g/l CI Disperse Rubine Mix. The fabric was then dried in the manner described in Sample AA.

Sample AM was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with an alginate based print paste as described above in Sample AA. The print paste also included 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The paste also included 10% of Solopol ZB30, a sugar co-polymer supplied by Stockhausen, Inc. The chemical substance was dried in the manner described in Sample AA. The fabric was then dyed in a lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then dried in the manner described in Sample AA.

Sample AN was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with an alginate based print paste as described above in Sample AA. The chemical substance also included 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The chemical substance was dried in the manner described in Sample AA. The fabric was then dyed in a lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI

Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then dried as described in Sample AA.

Sample AO was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with an alginate based print paste as described above in Sample AA. The paste also included 6% of the fluorochemical APG 5264. The chemical substance also included 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The chemical substance was dried in the manner described in Sample AA. The fabric was then dyed in a lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then dried in the manner described in Sample AA.

Sample AP was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with an alginate based print paste as described above in Sample AA. The paste also included 6% of the fluorochemical APG 85. The chemical substance also included 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The chemical substance was dried in the manner described in Sample AA. The fabric was then dyed in a lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then dried in the manner described in Sample AA.

Sample AQ was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with a synthetic based print paste containing 17.4 kg water, 12.114 g/kg concentrated synthetic paste (sold under the tradename WTA by Abco Industries of Roebuck, South Carolina), and minor quantities of a sequestering agent, a defoamer and an antimicrobial agent to facilitate printing performance. The paste was stiff and therefore was not tested for viscosity. The paste was dried using a laboratory infrared conveyor dryer of

the variety marketed by Glenro Inc. of Paterson, New Jersey, set at 65% output with a conveyor speed of 1.96 m/min. and a temperature between 220 and 330°F. The fabric was then dyed in a lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 5.10 g/l CI Disperse Orange 30, 11.97 g/l CI Disperse Blue 165, and 5.65 g/l CI Disperse Rubine Mix. The fabric was then dried in the infrared drying unit at a temperature not exceeding 300°F.

Sample AR was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with a synthetic based print paste of the variety described in Sample AQ. However, the print paste also included 6% Hipochem FCX fluorocarbon extender, distributed by High Point Chemical Co. of High Point, North Carolina. The fabric was dried in the manner described in Sample AQ. The fabric was then dyed in a lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, and 0.700 g/l CI Disperse Rubine Mix. The fabric was then dried in the infrared drying unit at a temperature not exceeding 300°F.

Sample AS was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with a synthetic based print paste of the variety described in Sample AQ. The fabric was then dried in the manner described in Sample AQ. The fabric was then dyed in a lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then dried in the manner described in Sample AQ.

Sample AT was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with a synthetic based print paste of the variety described in Sample AQ. The paste also included 6% Hipochem FCX fluorocarbon extender. The fabric was then dried in the manner described in Sample AQ. The fabric was then dyed in a lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse

Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then dried in the manner described in Sample AQ.

5 Sample AU was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with a synthetic print paste of the variety described in Sample AQ. The paste also included 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The fabric was dried in the manner described in Sample AQ, and then dyed in a lab
10 thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, and 0.700 g/l CI Disperse Rubine Mix. The fabric was then dried in the infrared drying unit at a temperature not exceeding 300°F.

15 Sample AV was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with a synthetic print paste of the variety described in Sample AQ, with the paste also containing 6% Hipochem FCX fluorocarbon extender along with 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The fabric was dried in
20 the manner described in Sample AQ, then dyed in a lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, and 0.700 g/l CI Disperse Rubine Mix. The fabric was then dried in the infrared drying unit at a temperature not exceeding 300°F.

25 Sample AW was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with a synthetic print paste of the variety described in Sample AQ. The paste also included 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The fabric
30 was dried in the manner described in Sample AQ, then dyed in a lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat

Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then dried in the manner described in Sample AQ.

Sample AX was the same base fabric as Sample AA. The fabric was printed in a wide bar pattern with a synthetic print paste of the variety described in Sample AQ. The paste also included 6% Hipochem FCX fluorocarbon extender and 1.35 g/kg disperse red mix, 0.41 g/kg disperse blue 60, and 8.2 g/kg disperse violet 57 dye. The fabric was dried in the manner described in Sample AQ, then dyed in a lab thermosol/pad/steam unit at 425°F for 50 seconds with the following dye mixture: 2.469 g/l CI Disperse Orange 30, 0.729 g/l CI Disperse Blue 165, 0.700 g/l CI Disperse Rubine Mix, 1.986 g/l CI Vat Yellow Mix, 1.811 g/l CI Vat Red 10, and 3.394 g/l CI Vat Black 22. The fabric was then dried in the manner described in Sample AQ.

The color data was tested using the method described above. The relative dE, dL, da, db and strength for each sample (for the portion having the chemical substance relative to the portion of the fabric not having the chemical substance) were calculated. The results are listed below in Table C.

TABLE C

	dE	dL	da	db	Strength (%)
AA	13.858	13.764	0.092	-1.609	39.2
AB	15.391	15.359	0.161	-0.977	35.52
AC	17.106	17.093	0.031	-0.654	31.76
AD	16.026	15.969	0.07	-1.345	33.95
AE	16.37	16.246	1.268	1.556	34.86
AF	17.129	16.983	1.824	1.293	33.01
AG	19.682	19.496	1.95	1.869	28.07
AH	18.319	18.182	1.359	1.775	30.67
AI	14.75	10.127	-6.124	-8.804	50.24
AJ	13.937	8.904	-5.865	-8.976	54.23
AK	16.551	8.624	-7.508	-11.966	55.85
AL	16.87	8.054	-7.872	-12.561	58.2
AM	15.814	8.653	-7.604	-10.834	57.03
AN	15.939	7.56	-7.742	-11.703	61.25
AO	18.173	6.821	-8.024	-14.811	64.18
AP	18.591	5.07	-8.062	-15.966	72.28
AQ	5.681	5.622	-0.091	-0.808	67.8

AR	7.701	7.643	0.041	0.91	60.55
AS	8.6	8.652	0.095	0.35	56.6
AT	10.421	10.353	0.17	1.175	51.13
AU	7.414	2.905	-3.902	-5.595	80.85
AV	7.463	2.752	-4.63	-5.16	82.6
AW	12.73	1.144	-6.616	-10.815	92.22
AX	12.698	0.0601	-6.914	-10.633	95.99

As noted from the examples, both the synthetic and the alginate print pastes enabled the production of patterned fabrics using a continuous dye process. However, the alginate was found to perform better than the particular synthetic print paste used based upon the specific conditions (viscosity, pressure, screen mesh, etc) used. However, it was found that each of the pastes tested provided good patterning while minimizing the strength loss of the fabric. It is noted that varying degrees of resistance of dyeing can be achieved using the process of the invention, through the selection of the type of resist chemistry, application method, substrate, and dyes used, and the like. Patterns using high to substantially complete resistance as well as those having lower levels of resistance (to achieve only subtle color variations) are all contemplated within the scope of the invention.

The fabrics produced according to the invention can be used in any end use where patterned textiles would have utility, including but not limited to apparel, home furnishings, napery, industrial products, or the like. As evidenced by the durability of the products following industrial launderings, the fabrics will have particular utility in the manufacture of garments used in the rental laundry markets.

In the specification there has been set forth a preferred embodiment of the invention, and although specific terms are employed, they are used in a generic and descriptive sense only and not for purpose of limitation, the scope of the invention being defined in the claims.